

a Lanner Falcon (*Falco lanarius*), East European, presented by Lord Lilford, F.Z.S.; a Wood Owl (*Syrnium aluco*), European, presented by Capt. F. Lloyd; two Vulturine Guinea Fowls (*Numida vulturina*), four Elliot's Guinea Fowls (*Numida ellioti*), three Mitred Guinea Fowls (*Numida mitrata*) from East Africa, deposited; a Pileated Jay (*Cyanocorax pileata*) from South America, two Black Storks (*Ciconia nigra*), European, purchased; a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, a Black Hornbill (*Buceros atratus*) from West Africa, four Specious Pigeons (*Columba speciosa*), a Banded Tinamou (*Crypturus noctivagus*) from South America, received in exchange; an Amherst Pheasant (*Thaumalea amherstiae*), three Fork-tailed Jungle Fowls (*Gallus furcatus*), three Chilian Pintails (*Dafila spinicauda*), seven Brazilian Teal (*Querquedula brasiliensis*), an Australian Wild Duck (*Anas superciliosa*), bred in the Gardens.

ON SPHENOPHYLLUM, ASTEROPHYLLITES, AND CALAMITES¹

I HAVE just received from Herr D. Stur an abstract of a memoir in which he announces that he has obtained a specimen from the Carboniferous rocks in which he finds twigs of Asterophyllites and Sphenophyllum, forming the branches of the stem of a Calamite, and that the strobili of Bruckmannia occur at the ends of such of the branches as support Sphenophylloid leaves. Herr D. Stur appears to regard Sphenophyllum as representing the foliage of the fruiting twigs of the plant, whilst Asterophyllites represents the ordinary vegetative foliage of the same plant.

That this should be true, so far as regards the unity of Asterophyllites and Sphenophyllum is concerned, appears to me to be most probable. As you are aware, I carefully investigated this subject in Part V. of my series of memoirs "On the Organisation of the Fossil Plants of the Coal-Measures." Accepting the conclusions of M. Renault, published in some of his valuable memoirs on the St. Etienne plants, as conclusive so far as Sphenophyllum is concerned, I showed that plants which are undoubtedly examples of Asterophyllites have stems the internal structure of which is identical with that of M. Renault's Sphenophyllums. These facts led me to the inevitable conclusion that the two genera were very closely allied to one another. In my Memoir, Part IX., I described an additional specimen (Fig. 32), which gave further support to my previously expressed opinion, and the further investigations which I then conducted led me unhesitatingly to affirm "that Asterophyllites and Sphenophyllum are genera so closely allied, that their separate existence finds but little justification in nature" (*loc. cit.*, p. 334). In fact, it has long appeared to me that, morphologically, the leaflet of Sphenophyllum was merely the resultant of the coalescence of two or three leaflets of Asterophyllites.

Herr D. Stur's discovery appears to afford an unanswerable confirmation of these views. His further discovery of Volkmannia² connected with his plant, which combines Sphenophyllum with Asterophyllites, further sustains a conclusion which I have arrived at in my memoir, Part V., pp. 55-56, viz., "that *Calamostachys* (Volkmannia) *binneyana* has much closer affinities with Asterophyllites than with Calamites" (*loc. cit.*, p. 65).

But Herr Stur further states that the stem from which these Asterophyllitean and Sphenophylloid twigs spring is a Calamites which he names *Calamites sachsi*. Not being acquainted with the plant to which he gives this name, I can form no opinion as to its nature; but I must confess I find it impossible to believe that it can be a Calamite of the common and only type which we find in England. Both my memoirs, Part I. and Part IX.,

contain a series of illustrations of the structure of our English Calamites, from that of stems that must have been nearly half a metre in diameter down to twigs having only a diameter of '000837 of a metre, which latter specimens are, I presume, the most minute examples that have been recorded by any observer. Yet all these graduated Calamites have exactly the same typical structure; they possess an ample medulla, which becomes fistular at an early age; this is surrounded by a circle of longitudinal canals, which run from node to node. External to each canal we find a corresponding wedge-shaped mass of radiating vascular laminae. These wedges are widely separated, in young plants and branches, by large, radial prolongations of the pith—the primary medullary rays of my memoirs—but in older branches these rays diminish in size, so that the wedges become blended together at their broad sub-cortical portions. These Zylem structures are enclosed within a true Phloem, which is uniformly parenchymatous in its young state, but which becomes differentiated into two or more layers, as the plant grows older; the chief of these layers, so far as size is concerned, being a thick mass of prosenchyma. Now the internal structure of Asterophyllites and Sphenophyllum differs from that of Calamites in every one of these features. The youngest twigs, as well as the larger branches of these two genera, are equally devoid of a medulla. The place occupied by that cellular tissue in the young Calamite is filled, in equally young twigs of Asterophyllites and Sphenophyllum by an exclusively vascular bundle, transverse sections of which exhibit the form of a remarkable triangle with three very concave sides. There are no inter-nodal canals, and the vascular zone, which is largely developed externally to the primary triangular vascular bundle by an exogenous process of growth, is not divided into separate wedges by large primary medullary rays. In Calamites each vascular wedge is subdivided into laminae by numerous, perfectly developed, secondary medullary rays. In Asterophyllites and Sphenophyllum, these rays are of the most rudimentary character, though they exist, as my friend M. Renault has shown, in the shape of groups of cells distributed through the vascular zone.¹

The bark of the two genera in question is as distinct from that of Calamites as are the medullary and Zylem portions of the respective stems. It consists of two layers which have no counterparts in the Phloem of Calamites. In addition to these details, there is a general triquetrous arrangement in the organisation of Asterophyllites and Sphenophyllum, which has no existence in Calamites. The foliar vascular bundles of the former are only given off from the apex of each of the three prolonged angles of the central triangular bundle of the young twig, whilst no one of the wedges forming the regular Zylem-cylinder of the Calamite has any predominance over the rest.

Such extreme and fundamental differences as these, affecting, as they do, the structure of every layer of tissue from the centre to the periphery of the axis, and at every stage of its growth, make it absolutely impossible that Asterophyllites and Sphenophyllum can be associated with any of the Calamites that are so abundant in our English coal-measures, and with the organisation of which we are now so perfectly acquainted.

That the stem so long, but so improperly, associated with the genus Calamites, viz., the *Calamites verticillatus* of Lindley and Hutton may have been the arborescent stem of these Sphenophylloid plants is as I have shown in my Memoir, Part V., extremely probable. But, I repeat, this stem has no claim whatever to be included amongst the true Calamites.

Such being the conclusions at which I have arrived from the careful study of the inner structure of an enormous number of stems of Calamites and Asterophyllites, and from a comparison of these latter with the facts published in the valuable Memoirs of M. Renault on Sphenophyllum, I shall look forward with great interest to the results of a critical examination of the stem which our fellow-labourer at Vienna has discovered.

W. C. WILLIAMSON

Further Remarks to the Preceding Treatise, by E. Weiss, Berlin

Stur's remarkable paper, to which the above communication of Prof. Williamson, the esteemed investigator of Manchester, refers, is the description of a slab on which several branches of Asterophyllites give off, at certain points, lateral twigs with the foliage of *Sphenophyllum dichotomum*, some of which bear terminal spikes of Volkmannia, Stur; at other points he finds

¹ So imperfect is the organisation of these medullary rays, that M. Renault is not prepared to recognise their claim to the title, a point on which I am obliged to differ from him.

¹ This brief contribution was originally a letter to Prof. Weiss, of Berlin, but it was kindly translated by him, and published in the *Neuen Jahrbuch für Mineralogie, Geologie und Paläontologie*, Jahrgang, 1872, as a communication, with the title of "Sphenophyllum, Asterophyllites, und Calamites, deren Stellung zu einander nach den letzten Beobachtungen." It is only republished now as being necessary to the understanding of Prof. Weiss's interesting communication, which he published along with mine, and which it appears to me desirable to republish for the benefit of English palaeobotanists. I am indebted to my friend Mr. Hartog for its translation into English.

² Herr Stur's Bruckmannia appear to be that form of spike long designated Volkmannia, but now separated as Calamostachys, and of which the *Calamostachys binneyana* is the only British example with the internal organisation of which we are acquainted.

the same *Asterophyllites* bearing spikes of the type *Bruckmannia*, Stur, and in such relations that it can only be the offset from a *Calamites* found lying with it, of which no definition is given, but which has previously been designated *C. sachsii*, Stur. From this Stur draws the following conclusions:—1. *Sphenophyllum* is a branch of *Asterophyllites*. (2) Both *Sphenophyllum* and *Asterophyllites* are branches of a *Calamites*. (3) *Sphenophyllum* is not a distinct botanical genus, but the Macrosporophorous branch of an *Asterophyllites*—that is of a *Calamites*. This, if correct, would be one of the most remarkable results in Palæophytology. A *Calamites* bearing not only twigs, ascribed hitherto to different genera, but to such different fructifications! and besides, we have the incompatibility in the anatomical structure of the stems of *Calamites* and *Sphenophyllum*, to which Williamson's remarks are directed. It is not every one that can step so lightly over these difficulties in order to unite the three genera into one. Some grounds, one would think, are still left, not only to indicate, but to compel the separation of these genera, and even to warrant their location in different families, and to call for caution in the interpretation of such facts as the above. To estimate the importance of these facts, we will call attention to the present state of the question.

The widespread genus *Calamites*, whose structure has been elucidated by Williamson and others, is now almost universally associated with *Equisetum* in the group *Calamariæ*, while, as is known, *Sphenophyllum* has been repeatedly classed with *Lycopodiaceæ* within the last few years. Williamson insists on the anatomical incompatibility between *Calamites* and *Sphenophyllum* (with which he includes *Asterophyllites*) as brought out by his own microscopical researches; and indeed all previous investigations in botany would protest against the insertion of twigs with the structure of *Sphenophyllum* on stems or branches, with the structure of *Calamites*. They possess, in common, only the external characters of the transverse segmentation of the stem, and the conformity of the separate internodes; but this conformity of segmentation is the chief ground for Stur's view, that all such genera as *Annularia*, *Asterophyllites*, and now also *Sphenophyllum*, pass into *Calamites*. Many stems, such as that bearing *Stachannularia tuberculata* (see my Carboniferous *Calamites* in *Abhandl. zur geol. Specialkarte von Preussen*, Band ii. Heft i., Taf. ii. Fig. 1), are *Calamites* in his eyes, which others do not recognise as such, and he will not allow of any [systematic] severance of a section of the *Calamarioid* stems from *Calamites* proper. Hence it is that from *Calamites*, Stur, most divers things ramify.

In the second point of importance, however, the close conformity of *Asterophyllites* and *Sphenophyllum*, Williamson agrees with Stur. According to him, either the two genera have altogether the same anatomical structure, or, at least, there are plants resembling the former having the stem-structure of the latter. Renault, on the contrary, is convinced that some of Williamson's preparations really belong to *Sphenophyllum*, agreeing with the fragments from Autun and St. Etienne investigated by himself.¹ The twigs which show *Calamite* structure are referred by Williamson to *Calamites*, and appear to be those which, without a knowledge of their internal structure, would be placed in *Asterophyllites*. These would come under *Calamocladus* of Schimper, whilst Williamson's *Asterophyllites* appear to be next related to *Sphenophyllum*.

These two forms agree so closely in the external characters of their sterile parts as to be undistinguishable without microscopic investigation; so that one is inclined to leave them together under the old provisional generic name of *Asterophyllites*, despite their probable essential difference. That section of *Asterophyllites* which shows the same stem-structure as *Sphenophyllum* may be allowed to be closely allied thereto, and, in some cases, even to belong to the same individual as Stur's discovery would indicate. It is possible that in well preserved fossils we may still find some single [external] character, which will distinguish this section of *Asterophyllites* from those which approach *Calamites*. It would lie in the decided trimery of the leaves in the verticils of the former (when regularly developed), corresponding with the triangular bundle of the axis, from the angles of which the vessels of the leaf spring. The difference of leaf-form as an absolute character, separating *Asterophyllites* and *Sphenophyllum* must now be given up.

From the botanist's point of view there is another very im-

¹ On this point M. Renault is mistaken; they differ in the chief features which distinguish *Sphenophyllum* from *Asterophyllites*, viz., in the number and shape of the leaves and in the number of the separate vascular bundles given off to these leaves.—W. C. W.

portant ordinal or generic distinction, to be found in the fructification. Every one must be astonished at Stur's pointing out both *Bruckmannia* and *Volkmanina* spikes on his plant. By the former he means *Calamarioid* spikes with sporangio-phores and sporangia between pairs of approximated verticils of Bracts (*Calamostachys*, Auct.). By the latter, spikes with sporangio-phores and the sporangia axillary (*Palæostachya*, Weiss.) Whether these two arrangements are really present here is not yet clearly shown; at least, in answer to my inquiries, Stur gives no definite information on that point, but refers to the forthcoming fuller memoir which he promises. Hence it is still an open question whether the arrangement is not that hitherto alone recognised as that of *Sphenophyllum*—that is, sporangia without sporangio-phores, sessile in or near the axils of the leaves. This mode of attachment may certainly also be concluded from Renault's last excellent communication ("Nouvelles Recherches sur la Structure des *Sphenophyllum*," *Ann. d. Sc. Nat. Bot.*, 1877). My own observations on a beautiful spike from Wettin, give the same result.

But it must also be borne in mind that those spikes to which I have thought right to restrict the name *Volkmanina*, which in all probability belong to twigs with the foliage of *Asterophyllites*, have the same sessile, axillary sporangia, so far as can be determined. If this be correct, however, there can be no difficulty from this point of view in uniting these *Volkmanina* (not Sturs, which belong to *Palæostachya*) with the spikes of *Sphenophyllum* into a single group. This is a further corroboration of my formerly expressed conclusion, that the two form a group which must be removed from the *Calamariæ*.

On summing up the results of these critical comparisons, we find (what has not yet been thoroughly contradicted) that *Sphenophyllum* may be grouped under *Lycopodiaceæ*, anatomical structure and fructification alike removing it from *Calamariæ*. Only it becomes more and more impossible to dispute that the convenient generic names *Calamites*, *Asterophyllites*, &c., are purely provisional—unfitted, it is true, to show the real relations of the plants that bear them, but indispensable, in the great majority of cases, where the material is insufficient for complete investigation, important though it be. Plants with stems and leaves of undistinguishable appearance, especially in the ordinary state of preservation, but with such different fructifications as *Calamostachys* and *Palæostachya*, for instance, must retain their autonomy, and *Sphenophyllum* still more so. It is not every arborescent *Calamarioid* stem, not every so-called *Calamites* that belongs to this botanical genus. It has now become very evident that what has been hitherto termed *Asterophyllites*, comprises plants of several groups; yet *Cingularia* and *Bowmannites* had already been distinguished, though they both possessed the stem of *Asterophyllites*, as regards external structure and foliation. We see that the practical difficulties in the distinction and nomenclature of fossils are augmented; but this lies in the very nature of the case. It is thus unnecessary to doubt the co-existence of *Asterophyllites* and *Sphenophyllum* twigs on one plant, as Stur has observed, without going on to admit his conclusions that *Asterophyllites*, as a whole, is identical with *Sphenophyllum*, and that both are *Calamites*. If the spikes cited are really *Calamostachys* (*Bruckmannia*, Stur) and *Palæostachya* (*Volkmanina*, Stur), this would show the distinctness of the fossils regarded by him as identical. Renault has found both macrosporangia and microsporangia on the same spike of *Sphenophyllum*; this tells against the view that *Volkmanina*, Stur (that is, in this case, the *Sphenophyllum* spike) is the female, and *Bruckmannia*, Stur, the male fruiting spike of one and the same plant. It will be seen how desirable it is to have further cautious investigation and careful publication upon the interesting find on which we are to base such far-reaching conclusions as those which Stur has lately drawn.

ANTHROPOLOGICAL INQUIRY IN FRANCE

THE published reports of the proceedings of the Société d'Anthropologie de Paris, for the year ending in the autumn of 1878, testify as usual to the diligence and zeal of a large number of its members. Limiting ourselves to the notice of papers which deal with questions of French local paleontology and sociology, we will begin our *résumé* by drawing attention to the interesting labours of M. Prunières, who has laid before the Society the result of several years' exploration of the Beaumes-Chaudes caverns in Lozère, the largest prehistoric ossuary yet brought to light. Here he recovered the remains of